Technology Roadmap
Energy Efficiency for California's Foo

Sponsored by CEC since 2000

Focus on Energy Efficiency and Environmental Fa

Process facilitated by CIFAR
- Food Industry Advisory Committee (FIAC) fo
- Industry Characterized
- Vision, Mission and Targets set
- Priority Issues Identified
- Challenges and Recommendations

Solicitation and Awards

FIAC

Armen Abrahamian, SCE, Irwindale
Bruce Berven, California Beef Council, Pleasanton
Dilip Chandarana, CRM (processing authority), Stockton
Jerry Cordy, Pacific Coast Producers, Walnut Grove
Patsy Dugger, PG&E, San Francisco
Grant Duhon, PG&E, San Francisco
Jim Gorny, International Fresh-cut Produce Association, Davis
Dee Graham, R & D Enterprises, Walnut Creek
Philip Greene, Foster Farms, Livingston
Rich Guthrie, Sacramento Municipal Utility District, Sacramento
Gregory Hribar, CTTCA, Sacramento
Keith Ito, National Food Processors Association, Dublin
Mark Jagodzinski,SMUD, Sacramento
Rachel Kaldor, Dairy Institute of California, Sacramento
Abizer Khairullah, Gilroy Foods, Gilroy
Walter King, King & Associates, Kerman
Glen Lewis, Del Monte Foods, Modesto
Richard Machado, Chem File, Fresno
Rosemary Mucklow, National Meat Association, Oakland
Joe O'Donnell, California Dairy Research Foundation, Davis

Lourminia Sen, CDFA, Sacramento
Bob Smittcamp, Lyons Magnus, Fresno
Ted Struckmeyer, Hilmar Foods, Hilmar
Tom Wong, Valley Research, Modesto
Jenny Wright, General Mills, Lodi
Ed Yates, CLFP, Sacramento

Sam Cunningham
Sa Ho
Todd Harter

Ricardo Amon, CEC
Pramod Kulkarni,CEC

Suanne Klahorst, UCD
Jatal Mannapperuma, UCD
David Reid, UCD
Sharon Shoemaker, UCD
Jim Thompson, UCD

Focus: California Food Processing Sector

energy, environment and economics

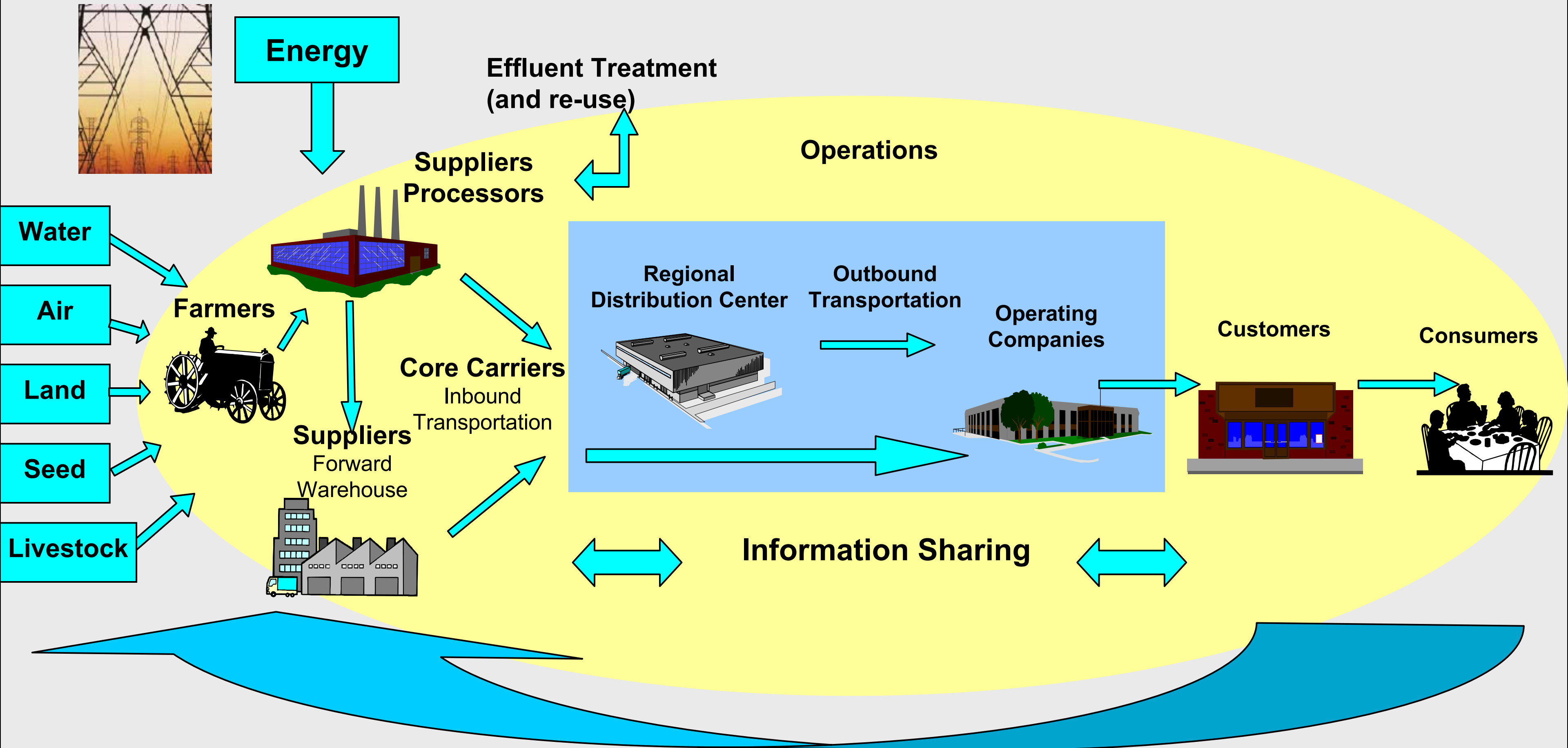
- **Huge** (#1 in USA output, $41.8-50B-shipments)
- **Diverse**
- **Third largest energy user**
- **Safety and security are key**
- **Resource and environmental dominate**

Trends….. and Drivers

Food product reformulation
Commodity processing
New processing methods
Complete and better byproduct utilization
A food distribution system

Global competition
Safety and security
Energy quality, reliability and cost
Water availability, quality and cost
Waste reduction and liability
Air quality issues
Residue analysis
Cost and quality of labor

The Food Distribution System



Recovery and reuse of waste materials, water and energy

Ref: adapted from Sysco presentation at RCA, March 2003

Roadmap Objectives

Define a current baseline for energy consumpti
water use, and management practices that incor
water and air quality standards.

Identify key needs and industry targets to sel
emerging technologies that require public rese
development and demonstration investments.

Prioritize RD&D investments to increase energy
water use efficiencies while minimizing negat
environmental impacts.

Estimated Value Added for Food Processing in California

Food Processing Sector	**Value (in billions)**
Fruits & Vegetables[1]	$10
Dairy[2]	$35
Beef and Poultry[3]	$8.5
Wine[4]	$9.9
Rice[5]	$0.5
Total	**$63.9**

[1]CLFP data, 2003, post harvest only and does not include irrigation water.
[2]N. Fletcher, 2003, Dairy Issues Forum
[3]Personal Communications, California Beef Council, 2002 ($5B); Bill Mattis, California Poultry Federation, 2004, ($3.5B)
[4]Wine Institute, 2003
[5]California Rice Commission, 2004

Estimated Annual Water and Energy Use of Major Food Processing Sectors in California

Food Processing Sector	Water (Million Gallons)	Gas (Million Therms)	Electricity (Million KWH)
Fruits & Vegetables[1]	30,000	300-400	600-800
Dairy			
Cheese[2]	600	43	583
Milk Powder/Butter[3]	360	33	130
Meat			
Beef[4]	1200	5	88
Poultry[5]	2000	40	360
Wine[6]	2900	23	406
Rice[7]	Negligible	41	316
Refrigerated Warehouses[8]	Negligible	Negligible	1000

[1]CLFP data, 2003, postharvest only and does not include irrigation water.

[2]Personal communication, T. Struckmeyer, Hilmar Cheese, 2004, (does not include water and energy for production of raw milk but does include whey processing, which is an integral part of cheese making)

[4]Personal communication, J. Gomes, California Dairies, Inc., 2004

[4]Personal communication, Jim Oltjen, UC Davis, 2004 (608gal/animals slaughtered) and Cattle Buyers Weekly, Dec 2003 (# animals slaughtered), and personal communication, J. Maxey, Beef Packers, Fresno. Numbers reflect slaughtering plants only.

[5]Personal communication, Bill Mattis, California Poultry Federation, 2004

[6]Alcohol, Tobacco, Tax and Trade Business, Dec. 2001 (574 M gal wine produced), and Wine Institute report (5 gal water per gal wine), (does not include water inputs to production of grapes)

[7]Personal communication, J. Mannapperuma, 2003 (drying only)

[8]Personal communication, International Association of Refrigerated Warehouses, and World Food Logistics Organization, 2004.

Estimated Total Annual Effluent Water Discharge

within Major Food Processing Sectors in California

Food Processing Sector	Total Water Discharge (Billion Gallons)
Fruits & Vegetables[1]	29
Dairy	
Cheese[2]	**2.1**
Milk Powder/Butter[3]	1.0
Meat	
Beef[4]	1.0
Poultry[5]	1.2
Wine[6]	2.5

[1]Personal communication, Ed Yates, CLFP, 2004 (estimated as 88% of water use)
[2]Personal communication, T. Struckmeyer, Hilmar Cheese, 2004
[3]Personal communication, J. Gomes, California Dairies Inc., 2004
[4]Personal communication, J. Maxey, Beef Packers, Fresno. 2004
[5]Personal communication, Bill Mattis, California Poultry Federation, and Dr. Jurgen Strasser, Process and Equipment Technology, 2004
\[6]Estimated as 88% of water use

Estimated Distribution of Energy (%) within Major Food Processing Sectors in California

ood Processing Sector	Pumps Motors Fans Conveyors Lighting	Pasteurization Heating Systems Evaporators Dryers Sterilization	Cooling Freezing Refrigeration	Sanitation Clean in Place
uits & egetables	10	70	15	5
airy				
Cheese	35	40	20	5
Milk Powder	25	55	15	5
eat				
Beef	30	20	40	10
Poultry	30	20	40	10
ine	50		40	10
ce (drying)	20	80		
efrigerated arehouses	15		80	5

Roadmap for the California Food Processing Industry

Vision

Continuously improve the global competitiveness of global food industry

Mission

Manage energy and other resources to meet or exceed all standards and benchmarks

Direction

To improve energy and productivity efficiencies and reduce water use

Targets

To provide cost savings with payback within 2 years

Goals	**Benchmarks**
Efficient use of energy Distributed power and flexible fuel plants Enterprise Energy and Asset Management Systems Microprocessor-based control systems Integrated unit operations Capture and re-use low grade power Best energy efficiency practices	Reduce energy use (KWh) per Ņstock keeping unitÓby 35%
Efficient use of water resources Capture and re-use water in plant	Reduce water use per Ņstock keeping unitÓby 40%
Total material handling and utilization	95+% of materials utilized; Reduced costs and liability
Safe and secure food supply Track and trace (on-line) Smart cards, radiofrequency identification	ŅSeal of safetyÓenhances consumer confidence
Environmental stewardship Adopt new air emission standards	ŅSustainableÓlabel enhances consumer loyalty

Technology Roadmap

Energy Efficiency in California's Food Industry

Prepared For:
California Energy Commission
Public Interest Energy Research Program

Prepared By:
Food Industry Advisory Committee
&
California Institute of Food and Agricultural Research
University of California, Davis

Arnold Schwarzenegger
Governor

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Priority Areas for Fundi

1. Opt. Equipment Performance
2. Validate Existing Technology
3. Improve Thermal Efficiencies
4. Opt. Cold Chain Management
5. Improve Power Quality and Reliability
6. Improve Water Use Efficiency
7. Improve Supply Chain Efficiency
8. Ensure Food Safety & Security
9. Adapt Seasonal Infrastructure

Need: Industrial Optimization

Targets

- Data collection and archiving for analysis
- Methods for data analyses and validation
- Optimization software demonstrations
- Assess understanding of optimizing components of systems

Need: Technology Validation

Targets

- Low-quality energy recovery processes (e.g. heat pumps).
- Separation technologies including electrodialysis and membranes
- Metering, sub-metering, systems overview and process simulation software.
- Maintenance systems and resource management.
- State-of-the-art electric motor technology.

Need: Thermal Efficiency Optimizat

Targets

- Automate process to reduce overall energy use by making the process more efficient with less human error, resulting in less re-work and waste.
- Adopt automatic microprocessor-based control devices and monitoring systems for temperature and humidity.
- Improved peak load management.
- Perform life cycle analysis to determine optimal efficiency.
- Utilization of waste heat for cooling through heat pumps.
- Cost effective retrofits for existing equipment.
- More efficient chillers, refrigerants, and compressors
- Efficient freezer configurations.
- Renewable energy-driven coolingImproved facility design by improving efficient, multi-state cooling.
- Consider the use of zone drying.

Need: Cooling Efficiencies in Ref. Wa

Target
s

- Blast freezing air velocity modulation
- Integrated hybrid refrigeration systems
- Utilize waste heat for cooling through heat pumps
- Improve facility design by improving efficient, multi-state cooling.
- Develop software to integrate and optimize container equipment.
- Control temperature in the distribution chain using control sensors for temperature, and humidity.
- Develop improved systems for ethylene removal

Need: Power Quality and Reliability

Targets

- Development of more reliable, powerful, and/or flexible uninterruptible power supplies or back- up power systems.

- Identification of technologies and engineering solutions to mitigate power quality problems.

Need: Improvement in Water Use Effic

- Establish benchmarks of energy and water use
- Use sensors and software to monitor and provide feedback
- System integration over entire plant
- Removal and recovery of solids in process water and reuse water within the processing plant.
- Employ water stream "segregation" of dissolved and particulate solids.
- Develop more efficient membranes that operate under conditions of high pressure, high pH, high solids, and are of low cost and low maintenance.
- Use in combination with pre- and post-treatment technologies to integrate water and energy and recover valuable solids and reuse water within processing plants.
- Evaluate ozone and other safe chemical alternatives to reduce the use of chlorine to control microbial growth, increasing the feasibility of water reuse.
- Use methane from waste decomposition in low energy activities.
- Recover low-grade heat from water
- Evaluate markets for byproducts of food processing.

Need: Supply Chain Waste Reduction

Targets

- Perform life cycle analyses using various existing and new processing scenarios to quantify energy, product, environmental, and social criteria.
- Evaluate processes with attention to waste utilization systems and re-design plant operations to minimize waste and recover by-products.
- Identification and isolation of pharmaceutical, food, feed components from residues and investigate functionality and new uses for by-products (whey and tartrates).
- Volume reduction of residues and wastes by liquid-liquid and solid-liquid separation and fractionation.
- Incineration of wastes (combustion and gasification) for energy generation

Need: Food Supply Safety

Targets

- Integrate post harvest treatment and management of the food supply to assure its safety from insects, rodents and microbial pathogens fungi, bacteria, viruses and parasites
- Develop a system for ethylene removal from closed environments
- Evaluate new preservation technologies such as coronation, ultraviolet, irradiation, hot water treatments, controlled atmosphere alone or in combinations
- Evaluate efficiency of sanitation agents and technologies (e.g. ozone, hot water, ultraviolet, electron beam, X-ray, and chlorine dioxide).
- Evaluate consequences of new processing technology (e.g., aseptic, high pressure, pulsed electric field, UHT and microwave) and alternative sterilization systems for efficiency

Need: Adapt Tech. to Seasonal Infras

Targets

- Optimize energy efficiency of dryers.
- Adoption of automatic control devices and monitoring systems.
- Use of lower air temperatures.
- Use of zone drying.
- Use more efficient blowers and burners.
- Solar drying and solar-assisted hot air drying.
- Link energy management systems to hardware.
- Develop computer models of processes yielding high quality product.
- Utilize flexible equipment to extend the process season, and handle a wide range of materials.
- Coordinate equipment and energy use between locations or coprocessors that operate at different times of the year.

Recommendations	Implementation
Distribute the roadmap to the California food industry to build awareness of technology development affording significant savings in energy, water and waste management that enables compliance with air and water quality regulations.	Roadmap draft finalized and published. Distribution lists include industrial, academic, and governmental and resource services stakeholders.
Provide assessments on potential benefits addressing the needs for energy and water technologies specific to food processing operations as expressed in the roadmap.	Some assessments will be included in all research projects and will be accomplished through coordination with other agencies and programs.
Effectively publish and disseminate information on technology throughout the state for the benefit of all sectors and sizes of food manufacturers in the state.	A newly formed Northwest States (STAC) collaborative will establish a food industry emerging technology clearinghouse of information to facilitate technology transfer opportunities.

Recommendations	Implementation
Support California food processing industry organizations with technical assistance to evaluate technology.	The PIER Food Industry Energy Research program conducted a first round of request for proposals and awarded six projects according to the research needs and priorities identified in this document. See Table 8 for potential energy savings.
Host public forums to maintain dialogues, nurture understanding, disseminate knowledge, and collect feedback from funded research.	A public forum at UC Davis in October, 2004 is the first to address progress on the R&D projects currently in progress.
Establish a Center of Excellence in Energy and Water Efficiency in Food Processing to centralize research, demonstration and transfer of technologies to the industry.	A source of funding would need to be identified to incorporate energy efficient demonstration into the new facilities breaking ground next year for food processing education at UC Davis.

Potential Energy Savings with R& D project

Project	Potential Energy Savings Million kWh	kTherms
Heat Exchanger Fouling	15	6,300
Infrared Drying of Rice	128	11,800
Retort/Cooler Optimization	36	-470
Low NOx Burner	65	0
Benchmarking Wineries	75	4,600
Adsorption Refrigeration	75	0
Wine Electrodialysis	28	0
Heat pump	3	380
Total Saving Potential	425	22,610